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IS 1885-3-2 (1966): Electrotechnical Vocabulary, Part III: Acoustics, Section 2: Acoustical and Electro-Acoustical System [LITD 7: Audio, Video and Multimedia Systems and Equipment]



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IS : 1885 (Part III/Sec 2) - 1966

(Reaffirmed 2001)

Indian Standard

ELECTROTECHNICAL VOCABULARY

PART III ACOUSTICS

Section 2 Acoustical and Electro-Acoustical System

(Second Reprint JANUARY 1989)

UDC 001.4:534.86

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Indian Standard

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Indian Standard

ELECTROTECHNICAL VOCABULARY

PART III ACOUSTICS

Section 2 Acoustical and Electro-Acoustical System

0. FOREWORD

0.1 This Indian Standard (Part III/Sec 2) was adopted by the Indian Standards Institution on 19 December 1966, after the draft finalized by the Electrotechnical Standards Sectional Committee, in consultation with the Acoustics Sectional Committee, had been approved by the Electrotechnical Division Council.

0.2 This Indian Standard has been prepared in view of the frequent need for definitions to be included in the different documents on amplifiers, loudspeakers and other related acoustic equipment, and with a view to bringing together the terms used in the field of acoustics. As a large number of aspects of acoustics, including electro-acoustics, is to be covered it has been decided to prepare this part in a number of sections, each dealing with a particular aspect of the subject.

0.2.1 This section, dealing with acoustical and electro-acoustical systems, includes terms relating to transmission systems, microphones, loudspeakers, etc.

0.2.2 The following other sections have so far been prepared:

Section 1 : Physical acoustics

Section 4 : Sonics, ultrasonics and underwater acoustics

Section 5 : Speech and hearing

0.2.3 The following sections are under preparation:

Section 3 : Sound recording and reproduction

Section 6 : Acoustical instruments

0.3 While preparing this standard an attempt has been made to follow, as far as possible, the definitions proposed by the International Electrotechnical Commission in their Pub 50(08)-1960 Electro-acoustics.

0.3.1 Assistance has also been derived from the following:

B.S. 661 : 1955 Glossary of acoustical terms. British Standards Institution.

ASAS 1.1-1960 Acoustical terminology (including mechanical shock and vibration). American Standards Association.

0.4 The electrotechnical vocabulary is being prepared in several parts, each having one or more sections. A list of other parts so far published is given on 4th cover.

1. SCOPE

1.1 This standard (Part III/Sec 2) covers terms relating to acoustical and electro-acoustical systems, such as transmission systems, microphones and loudspeakers.

2. ACOUSTICAL AND ELECTRO-ACOUSTICAL TRANSMISSION SYSTEMS

2.1 Acoustical System — A system adapted to generate, transmit and/or receive acoustic energy.

2.2 Input Impedance — The impedance measured at the input terminations.

2.3 Output Impedance — The impedance measured at the output terminations.

2.4 Dividing Network — A frequency selective network which divides the frequency spectrum into two or more parts.

2.5 All-Pass Network — A network designed to introduce phase shift or delay without introducing appreciable attenuation at any frequency.

2.6 Equivalent Network — A network that, under specified conditions, may replace another network.

2.7 Crossover Frequency — As applied to electric dividing networks, the frequency at which equal electric powers are delivered to each of the adjacent frequency channels when all channels are terminated in the loads specified.

2.8 Transmission Loss — The decrease in power, expressed in decibels, between two points of a transmission system.

2.9 Waveform Distortion — Any unwanted change in wave-form which occurs between two points in a sound transmission system.

2.10 Amplitude Vs Frequency Distortion — The distortion present when the ratio of the output to the input does not vary with respect to frequency in a desired manner.

2.11 Phase V s Frequency Distortion — The distortion present when the phase-shift between the output and the input does not vary with respect to frequency in a desired manner.

2.12 Non-linear Distortion — The distortion resulting from lack of constancy of the ratio between the instantaneous values of the output of the system and the corresponding instantaneous values of the input. Non-linear distortion includes amplitude distortion, harmonic distortion and intermodulation distortion.

2.12.1 Amplitude Distortion — A part of non-linear distortion present when the ratio of the magnitude of the fundamental component of the output to the magnitude of the sinusoidal input does not vary with respect to the magnitude of the input in a desired manner.

2.12.2 Harmonic Distortion — A part of non-linear distortion present when the output contains sinusoidal components whose frequencies are harmonics of the frequency of the sinusoidal input.

2.12.3 Intermodulation Distortion — A part of non-linear distortion present when the output contains sinusoidal components (intermodulation products) whose frequencies are combinations of the frequencies of the sinusoidal components of the complex input.

2.13 Transient Distortion — A type of distortion which occurs only as a result of rapid fluctuation in amplitude and/or frequency of the input. It is frequently manifested as a duration of frequency components in the response in excess of the duration of the input.

2.14 Sound System — A system of microphones, amplifiers and loud-speakers for amplifying and distributing sound to audience. When the audience is in the vicinity of the source the term ' Sound Reinforcement System ' is the term often used for it.

2.15 Stereophonic Sound System — A sound transmission system arranged to give to the listener an impression of the spatial distribution of sounds.

2.16 Monophonic Sound System — A transmission system in which, at some point, the signal passes through a single channel and does not give to the listener an impression of spatial distribution of sounds.

2.17 Cut-Off Frequency — A frequency of transition between transmission and attenuation.

2.17.1 Effective Cut-Off Frequency — A frequency at which the transmission of energy falls below some specified value.

2.18 Bandwidth — Of an ideal system which has uniform response between two frequencies and infinite attenuation at all other frequencies, the interval

between the cut-off frequencies expressed in octaves or as their difference in cycles per second.

2.18.1 Effective (Equivalent) Bandwidth — Of a specified transmission, the bandwidth of an ideal system:

- a) which has uniform transmission in its pass band equal to the maximum transmission of the specified system, and
- b) which transmits the same power as the specified system when the two systems are receiving equal input signals having a uniform distribution of energy at all frequencies.

Mathematically,

$$\text{Effective bandwidth} = \int_0^{\infty} G df$$

where

G = ratio of the power transmission at the frequency f to the transmission at the frequency of maximum transmission.

f = frequency in cycles per second, and

3. TRANSDUCERS

3.1 Transducer — A device designed to receive energy from one system and supply energy, generally of a different kind, to another in such a manner that the desired characteristics of the input energy appear at the output.

3.2 Passive Transducer — A transducer in which the output energy is derived exclusively from the input.

3.3 Active Transducer — A transducer in which the output energy is derived, at least in part, from sources other than the input.

3.4 Electromechanical Transducer — A transducer which is actuated by energy from an electrical system and supplies energy to a mechanical system or *vice versa*.

3.5 Electro-acoustic Transducer — A transducer which is actuated by energy from an electrical system and supplies energy to an acoustical system or *vice versa*.

3.6 Reversible Transducer — A transducer equally capable of transforming electrical energy into mechanical (or acoustic) energy or *vice versa*.

3.7 Ideal Passive Transducer — For connecting a specified source to a specified load, a hypothetical passive transducer that transfers the maximum possible power from the source to the load.

NOTE — In linear electric circuits and analogous cases, this is equivalent to a transducer which dissipates no energy, and which, when connected to the specified source and load, presents to each its conjugate.

3.8 Linear Transducer — A transducer for which the pertinent measures of all the waves concerned are linearly related.

3.9 Reciprocal Transducer — A transducer that satisfies the principle of reciprocity (*see 4.1*).

3.10 Unilateral Transducer — A transducer capable of transmission in one direction only between its terminations.

3.11 Bilateral Transducer — A transducer capable of transmission in either direction between its terminations.

3.12 Symmetrical Transducer — A transducer whose input and output image impedances are equal.

3.13 Asymmetrical Transducer — A transducer whose input and output image impedances are not equal.

3.14 Variable-Resistance Transducer -- A transducer that depends for its operation on variations in the electrical resistance.

3.15 Electrostatic (Capacitor) (Condenser) Transducer — A transducer which depends for its operation on variations of the electrical capacitance of a capacitor.

3.16 Piezo-electric Transducer — A transducer that depends for its operation on the deformation of a body having piezo-electric properties.

3.16.1 Crystal Transducer — A piezo-electric transducer of certain asymmetrical crystals.

3.16.2 Ceramic Transducer — A piezo-electric transducer of certain ceramic materials.

NOTE — Certain ceramic materials may have induced piezo-electric properties due to the application of electric field during manufacture.

3.17 Bender Transducer — A transducer in which an electromotive force is induced when the element undergoes flexural strain or, conversely, a flexural strain results from the application of electric charge or electric current.

NOTE — Usually, the element is an assembly of two or more crystals or ceramic pieces so arranged that one piece expands when the other contracts.

3.18 Electrostriction Transducer — A transducer that depends for its operation on the production on an elastic strain proportional to the square of the dielectric displacement.

3.19 Variable-Reluctance (Magnetic) (Electromagnetic) Transducer — A transducer that depends for its operation on variations in the reluctance of a magnetic circuit.

3.20 Magnetostriction Transducer — A transducer that depends for its operation on the deformation of a material having magnetostrictive properties.

3.21 Moving-Conductor Transducer — A transducer that depends for its operation on the generation of an electromotive force in a conductor moving in a magnetic field.

3.21.1 Moving-Coil Transducer — A moving-conductor transducer in which the conductor has the form of a coil.

3.21.2 Ribbon Transducer — A moving-conductor transducer in which the conductor has the form of a thin ribbon.

3.21.3 Induction Transducer — A moving-conductor transducer in which the conductor is coupled inductively to the external electric circuit.

3.22 Electronic (Electron Tube) Transducer — A unilateral transducer that depends for its operation on the generation of a voltage by the relative motion of the electrodes in a vacuum tube.

3.23 Ionophone — A unilateral transducer in which the sound output results from the interaction between an ionic plasma and the surrounding sound transmitting medium.

3.24 Thermal (Hot-Wire) Transducer — A unilateral transducer that depends for its operation on the change in resistance of a hot wire produced by the cooling or heating effects of a sound wave.

3.25 Pneumatic Transducer — A unilateral transducer in which the sound output results from the controlled variation of an air stream.

3.26 Transistor Transducer — A transducer which depends for its operation on the direct modification of semiconductor properties through strain applied to the material.

3.27 Electrokinetic Transducer — A transducer that depends for its operation on the dielectric polarization in certain liquids resulting from viscous shearing stress that accompanies flow through porous materials.

3.28 Split Transducer — A direction transducer in which electro-acoustic transducing elements are so divided and arranged that each division is electrically separated.

3.29 Diaphragm — Of a transducer, a portion (frequently a thin membrane) of the vibrating system, specially adapted to respond to or generate sound pressures.

3.30 Acoustic Radiating Element — Of a transducer, a vibrating surface in a transducer that can cause or be actuated by sound waves.

4. TRANSDUCER PARAMETERS

4.1 Reciprocity Principle — For an electro-acoustic, linear, passive, reversible transducer, the principle according to which the relation between the free-field voltage (or current) sensitivity of the transducer when used as a sound receiver and its free-field response to current (or voltage) when used as a sound emitter is independent of the transducer in question.

4.2 Reciprocity Coefficient — For an electro-acoustic transducer satisfying the reciprocity principle, the common value, at a particular frequency, of the following two quotients:

- a) That of the free-field voltage sensitivity of the transducer used as sound receiver and the free-field response to current of the same transducer used as sound emitter.
- b) That of the free-field current sensitivity of the transducer used as sound receiver and the free-field response to voltage of the same transducer used as sound emitter.

4.3 Sensitivity (Response) — The quantitative expression of the quotient of a specified quantity at the output of a transducer and another specified quantity at the input.

4.4 Relative Sensitivity (Relative Response) — The response under some particular conditions in relation to the under reference conditions stated explicitly.

4.5 Reference Axis (Principal Axis) — A reference direction for angular co-ordinates used in describing the directional characteristics of a transducer. It is usually an axis of structural symmetry or that direction of maximum response.

4.6 Axial Sensitivity (Axial Response) (at a Specified Frequency) — The free-field sensitivity for a sound wave, the direction of propagation of which coincides with the reference (principal) axis of the transducer.

4.7 Acoustical Centre (of a Sound-Emitting Transducer) — The point from which the spherical waves as observed at remote points appear to diverge.

NOTE — Due to practical difficulties of locating acoustical centre the term reference point located on the geometrical configuration of the transducer may be described in relevant specification.

4.8 Response to Power — At a given frequency, quotient of the mean-square sound pressure at a specified distance from the acoustical centre of the transducer and in a specified direction, and the electrical power input.

4.9 Response to Voltage — At a given frequency, quotient of the rms sound pressure at a given distance from the acoustical centre and in a specified direction, and the signal voltage applied at the input terminals.

4.10 Response to Current — At a given frequency, quotient of the rms sound pressure at a given distance from the acoustical centre and in a specified direction, and the current flowing at the electrical input terminals.

4.11 Directional Response Pattern (Directivity Pattern) — A description generally presented graphically of the response as a function of the direction of propagation of the radiated or incident sound in a specified plane through the acoustical centre and at a specified frequency.

4.12 Directivity Factor

- a) Of a transducer used for sound emission at a specified frequency, ratio of the mean square of the radiated free-field sound pressure at a fixed point on the principal axis to the mean square pressure averaged over a sphere passing through the fixed point and concentric with the transducer.
- b) Of a transducer used for sound reception at a specified frequency, ratio of the mean square of the electromotive force produced in response to sound waves arriving in a direction parallel to the principal axis to the mean square of the electromotive force that would be produced if sound waves having the same frequency and rms pressure were arriving at the transducer simultaneously from all directions.

4.13 Directional Gain (Directivity Index) — The directivity factor expressed in decibels.

Mathematically,

$$\text{Directivity index} = 10 \log_{10} (\text{Directivity factor})$$

4.14 Angular Deviation Loss — The response in decibels on the principal axis minus the response in decibels for a specified direction.

4.15 Electromechanical Coupling Factor — A factor used to characterize the extent to which the electrical characteristics of a transducer are modified by a coupled mechanical system, and *vice versa*.

4.16 Insertion Loss — Resulting from the insertion of a transducer in a transmission system, the ratio of the power delivered to that part of the system which will follow the transducer before the insertion of the transducer to that delivered to the same part of the system after the insertion of the transducer, expressed in decibels.

NOTE — If the input power or output power or both consist of more than one component, the particular component must be specified.

4.17 Transducer Dissipation Loss — Of a transducer operating between specified source and load, the ratio of the power delivered by the specified source when the transducer is connected to the specified load to the power delivered by the transducer to the specified load, expressed in decibels.

4.18 Shading — A method of controlling the directional response pattern of a transducer through the control of the distribution of phase and amplitude of the transducer action over its active face.

4.19 Beam Width — Of a directional transducer at a given frequency in a given plane including the beam axis, the angle included between the two directions, one to the left and the other to the right of the axis, at which the angular deviation loss has a specified value.

NOTE — Beam widths are commonly specified for an angular deviation loss of 3, 6 or 10 decibels, the choice depending upon the directivity of the transducer or upon its intended application. The particular angular deviation loss is stated by using a term, such as ' 3-dB beam width '.

4.20 Effective Beam Width — Under consideration.

4.21 Dynamic Range — Of a sound-receiving transducer, the difference between overload sound pressure level and the equivalent (internal) noise pressure level.

NOTE 1 — The useful dynamic range is limited at the low level end by noise in the medium (acoustic noise) or by electrical circuit noise. The nature of the noise limit must be stated explicitly (for example, ambient noise, equipment noise, thermal noise, etc).

NOTE 2 — The method of overload determination and the type of overload must be specified (that is, signal distortion, overheating, damage, etc).

4.22 Available Power

- a) Of a sound field with respect to a given object placed in it, the power which would be abstracted from the acoustic medium by an ideal transducer having the same dimensions and the same orientation as the given object. The dimensions and their orientation with respect to the sound field must be specified.

NOTE — The acoustic power available to a transducer in a plane-wave sound field of a given frequency is the product of the free-field sound intensity and the effective area of the transducer.

- b) Of a linear source of electric energy, the quotient of the mean square of the open-circuit terminal voltage of the source and four times the resistive component of the internal impedance of the source.

NOTE — The available power would be delivered to that load impedance which is the conjugate of the internal impedance of the source; it is the maximum-power that can be delivered by that source.

4.23 Available Power Response — Of a transducer used for sound emission, the quotient of the mean square sound pressure apparent at a distance of one metre in a specified direction from the effective acoustical centre of the transducer and the available electric power, under matched conditions.

4.24 Available Power Efficiency — Of a transducer used for sound reception, the ratio of the electric power available at the electric terminals of the transducer to the acoustic power available to the transducer, under matched conditions.

NOTE — For an electro-acoustic transducer which obeys the reciprocity principle, the available power efficiency in sound reception is equal to the transmitting efficiency.

4.25 Equivalent Noise Pressure (Inherent Noise Pressure) — Of a transducer or system used for sound reception, the root-mean-square sound pressure of a sinusoidal plane progressive wave which, if propagated parallel to the principal axis of the transducer, would produce an open-circuit signal voltage equal to the root mean square of the inherent open circuit noise voltage of the transducer in a transmission band having a bandwidth of 1 cycle per second and centered on the frequency of the plane sound wave.

NOTE — If the equivalent noise pressure of the transducer is a function of secondary variables, such as ambient temperature or pressure, the applicable values of these quantities should be stated explicitly.

4.26 Equivalent Noise Pressure Level — Of a transducer used for sound reception, the ratio of the equivalent noise pressure to the stated reference pressure, expressed in decibels.

4.27 Blocked Impedance — The electrical input impedance of the transducer when the mechanical load impedance is infinite, for example, when a diaphragm is rigidly clamped.

4.28 Motional Impedance — The difference between the electrical input impedance measured under a specified load and the blocked impedance.

5. FILTER

5.1 Filter — A device which transmits energy at frequencies within one or more frequency bands and attenuates energy at all other frequencies.

5.2 Low-Pass Filter — A filter which transmits energy at all frequencies below a certain frequency and attenuates at all higher frequencies.

5.3 High-Pass Filter — A filter which transmits energy at all frequencies above a certain frequency and attenuates at all lower frequencies.

5.4 Band-Pass Filter — A filter which transmits energy at all frequencies between two given frequencies and attenuates at all other frequencies.

5.5 Band-Rejection Filter — A filter which transmits energy at all frequencies outside a certain range and attenuates at all frequencies inside that range.

5.6 Nominal Upper and Lower Cut-Off Frequencies — Of a filter pass-band those frequencies above and below the frequency of maximum

response of a filter at which the response to a sinusoidal signal is 3 dB below the maximum response.

5.7 Nominal Pass-Band Centre Frequency — The geometric mean of the nominal cut-off frequencies.

5.8 Bandwidth of a Filter — The interval between the cut-off frequency (see 2.18), expressed in octave or as their difference in cycles per second.

5.8.1 Equivalent Bandwidth of a Band-Pass Filter (Analyser) — (see also 2.18.1) The bandwidth of an ideal system:

- a) which, for pure tone inputs, has a response in its pass-band equal to the maximum response of the system concerned; and
- b) which, for an input having a uniform distribution of energy with frequency, transmits the same energy.

6. MICROPHONES

6.1 Microphone — An electro-acoustic transducer operating from an acoustical system to an electrical system, the wave form remaining substantially unaltered in this operation.

6.2 Pressure Microphone — A microphone which responds substantially to sound pressure.

6.3 Pressure-Gradient Microphone — A microphone which responds substantially to the gradient of the sound pressure.

6.4 Velocity Microphone — A microphone in which the electric output substantially corresponds to the instantaneous particle velocity in the impressed sound wave.

6.5 Omnidirectional Microphone — A microphone the response of which is substantially independent of the direction of sound incidence.

6.6 Directional Microphone — A microphone the response of which is dependent on the direction of sound incidence.

6.6.1 Unidirectional Microphone — A microphone which is responsive predominantly to sound incident within a solid angle not greater than one hemisphere.

6.6.2 Bidirectional Microphone — A microphone which is responsive predominantly to sound incidence from two directions separated by 180 degrees.

6.7 Phase-Shift Microphone — A microphone employing phase-shift networks to produce directional properties.

6.8 Electrostatic (Capacitor) (Condenser) Microphone — A microphone which depends for its operation on variations of the electrical capacitance of a capacitor.

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6.9 Piezo-electric (Crystal) Microphone — A microphone which depends for its operation on the deformation of a body having piezo-electric properties.

6.10 Electromagnetic Microphone — A microphone which depends for its operation on variations of the reluctance of a magnetic circuit.

6.11 Thermal Microphone — A microphone which depends for its operation on changes in the resistance of a hot wire produced by the cooling or heating effects of a sound wave.

6.12 Magnetostriction Microphone — A microphone which depends for its operation on the deformation of a material having magnetostrictive properties.

6.13 Electronic (Electron Tube) Microphone — A microphone which depends for its operation on the variations of an electronic flux by the motion of one of the electrodes in a vacuum tube.

6.14 Ionic Microphone — A microphone which depends for its operation on the interaction between an ionic plasma and the surrounding air.

6.15 Carbon Microphone — A microphone which depends for its operation on the variations of electrical resistance at the contacts of carbon granules.

6.16 Moving-Conductor Microphone — A microphone which depends for its operation on the generation of an electromotive force in a conductor moving in a magnetic field.

6.16.1 Ribbon Microphone — A moving-conductor microphone in which the conductor has the form of a thin ribbon which is directly driven by sound waves.

6.16.2 Moving-Coil (Dynamic) Microphone — A moving-conductor microphone in which the conductor has the form of a coil.

6.17 Close-Talking Microphone — A microphone which is designed particularly for use close to the mouth of the speaker.

6.18 Noise-Cancelling Microphone (Anti-noise Microphone) — A close-talking microphone using pressure gradient operation to increase discrimination against ambient noise.

6.19 Lip Microphone — A microphone adapted for use in contact with the lips of the speaker.

6.20 Lapel Microphone — A microphone adapted to positioning on the clothing of the user.

6.21 Mask Microphone — A microphone designed for use inside a respiratory mask.

6.22 Throat Microphone — A microphone actuated by contact with the throat close to the larynx.

6.23 Standard Microphone — A microphone whose response in specified conditions is accurately known.

6.24 Probe Microphone — A microphone adapted to exploring a sound field without significantly disturbing it.

6.25 Combination Microphone — A microphone consisting of the combination of two or more similar or dissimilar microphones.

6.26 Line (Column) Microphone — A directional microphone consisting of a single, straight-line element or any array of contiguous or spaced electro-acoustic transducing elements arranged on a straight line or the acoustic equivalent of such an array.

6.27 Parabolic-Reflector Microphone — A microphone employing a parabolic reflector to improve its directivity.

6.28 Push-Pull Microphone — A microphone in which two like microphone elements actuated by the same sound wave operate 180 degrees out of phase.

6.29 Contact Microphone — A microphone actuated by contact with the sound generator.

6.30 Telephone Transmitter — A microphone for use in a telephone system.

7. MICROPHONE PARAMETERS

7.0 Generally the parameters described for microphones are applicable to hydrophones (*see 10.1*) also.

7.1 Free-Field Voltage Sensitivity (Response) — Of a microphone, for a specified frequency and a specified direction of sound:

- a) quotient of the output emf and the sound pressure in the undisturbed free field, and
- b) quotient of the voltage developed across the load resistance specified by the manufacturer and the sound pressure in the undisturbed free field.

7.2 Free-Field Current Sensitivity (Response) — Of a microphone, for a specified frequency and a specified direction of sound, quotient of the short-circuit current at the output terminals of the microphone and the sound pressure in the undisturbed free-field.

7.3 Random Sensitivity (Random-Incidence Response) (Sensitivity in a Diffuse Field) — Of a microphone, for a given frequency, the root-mean-square value of the free-field sensitivity for all angles of incidence of the sound wave.

7.4 Pressure Sensitivity (Response) — Of a microphone, for a given frequency:

- a) quotient of the output emf and the actual sound pressure existing over the region of the microphone designed to receive sound, and
- b) quotient of the voltage developed across the load resistance specified by the manufacturer of the microphone and the actual sound pressure existing over the region of the microphone designed to receive sound.

7.5 Close-Talking Sensitivity (Response) — Of a microphone, for specified frequency:

- a) quotient of the output emf and the sound pressure in the undisturbed sound field produced by a specified source, and
- b) quotient of the voltage developed across the load resistance specified by the manufacturer and the sound pressure in the undisturbed field produced by a specified source.

In either case the source should simulate the human head and mouth (artificial mouth).

7.6 Microphone Rating G_M — The quotient of the nominal electric power available from the microphone and the reference power divided by the ratio of the square of the free-field sound pressure to the reference sound pressure expressed in decibels. The standard symbol is G_M .

NOTE — For necessary formulae, see Appendix A.

7.7 Voltage Coupling Loss — Of a microphone, consisting of an electro-acoustic sound-receiving element and an associated electric network, the ratio of the open-circuit output voltage of the electro-acoustic element to the open-circuit voltage of the associated electric network. This is expressed in decibels as a function of frequency.

NOTE — To facilitate the use of an electro-acoustic element having high electrical impedance, the element is usually combined with an electric network, such as a pre-amplifier or transformer specified in terms of the open-circuit crystal voltage.

8. LOUDSPEAKERS

8.1 Loudspeaker — An electro-acoustic transducer operating from an electrical system to an acoustical system, the waveform remaining substantially unaltered in this operation.

8.2 Loudspeaker System — A combination of one or more loudspeakers and associated baffles, horns and dividing networks arranged to work together.

8.3 Electromagnetic Loudspeaker — A loudspeaker which depends for its operation on the variations of the reluctance of a magnetic circuit.

8.4 Electrostatic Loudspeaker — A loudspeaker which depends for its operation on electrostatic forces applied to the plates of a capacitor.

8.5 Piezo-electric Loudspeaker — A loudspeaker which depends for its operation on the deformation of a body having piezo-electric properties.

8.6 Magnetostriction Loudspeaker — A loudspeaker which depends for its operation on the magnetostrictive properties of a material.

8.7 Ionic Loudspeaker — A loudspeaker which depends for its operation on the interaction between an ionic plasma and the surrounding air.

8.8 Pneumatic Loudspeaker — A loudspeaker which depends for its operation on the controlled variations of an air stream.

8.9 Moving-Conductor (Moving-Coil) Loudspeaker — A loudspeaker which depends for its operation on the motion of a conductor, attached to a diaphragm and carrying a varying current, in a steady magnetic field.

8.10 Direct Radiator Loudspeaker — A loudspeaker whose radiating surface or diaphragm is in direct contact with the medium into which it radiates without the interposition of any acoustic impedance matching device.

8.11 Cone Loudspeaker — A loudspeaker in which the radiating element has the form of a cone.

8.12 Horn Loudspeaker — A loudspeaker in which the radiating element is coupled to the medium by means of a horn.

8.13 Multi-Cellular Loudspeaker — A horn loudspeaker in which the radiating element is coupled to the medium by means of two or more juxtaposed horns.

8.14 Column Loudspeaker — A group of loudspeakers of either direct radiator or horn type mounted close to each other to form a column on a suitable fixture. The loudspeakers are connected in phase and the sound radiated by the column is concentrated about a plane at right angles to that of the column itself.

8.15 Re-entrant (Folded) Horn — A horn which is folded upon itself to reduce its overall length.

8.16 Acoustic Horn — A tube of variable section, having terminal surfaces of different areas and intended to achieve an acoustic impedance match and, possibly, to produce a directional effect.

8.17 Conical Horn — A horn whose cross-sectional area increases as the square of the axial length.

8.18 Exponential Horn — A horn whose cross-sectional area increases exponentially with the axial distance.

8.18.1 Horn Mouth — Normally, the end of a horn with the large cross-sectional area.

8.18.2 Horn Throat — Normally, the end of a horn with the smaller cross-sectional area.

8.19 Baffle — A shielding device used in conjunction with a loudspeaker to increase the effective acoustic path between the front and the back of the loudspeaker.

8.20 Infinite Baffle — A baffle constructed so as to simulate one of infinite extent.

8.21 Reflex Baffle — A baffle in which a portion of the radiation from the rear of the diaphragm is propagated forward after controlled shift of phase or other modification to increase the overall radiation in some portion of the frequency spectrum.

8.22 Multi-Cellular Horn — A cluster of horns with juxtaposed mouths that lie in a common surface. The purpose of the cluster is to control the directional pattern of the radiated energy.

8.23 Multi-Channel Loudspeaker — A system of two or more loudspeakers, usually with dividing networks, designed to radiate simultaneously in particular frequency bands.

9. LOUDSPEAKER PARAMETERS

9.0 Generally, the parameters described for loudspeakers are applicable to underwater sound projectors (*see 10.2*) also.

9.1 Reference Point

- a) *Of a Direct Radiator Loudspeaker* — A point lying in the plane through the edge of the cone and at the geometrical centre of the openings.
- b) *Of a Horn Loudspeaker* — A point lying in the plane through the edge of the horn mouth and at its geometrical centre.

9.2 Acoustical Response — The sound pressure, absolute or relative under free-field conditions, resulting from a stated electrical input to the loudspeaker, produced at a specified position.

9.2.1 Frequency Response — A description, usually presented as a graph, of the response as a function of frequency measured at a stated position and at a specified constant voltage or constant current.

9.2.2 Directional Response — A description, usually presented as a graph, of the response as a function of the direction of propagation measured in a specified plane through the reference axis at a specified distance from the reference point and at specified frequencies or narrow bands of frequencies.

9.3 Resonance Frequency — That frequency at which the modulus of the electrical impedance has its first principal maximum in an ascending frequency scale.

9.4 Nominal Power — The power delivered from a source of substantially zero impedance if the actual loudspeaker is replaced by its rated impedance. It can be calculated from the rated impedance and the rms voltage across it. Thus,

$$\text{Nominal Power} = \frac{[\text{Voltage (rms) across the loudspeaker}]^2}{\text{Rated impedance}} \text{ watts}$$

9.5 Rated Sound Pressure Level — Average sound pressure level, over a stated frequency range, produced on the reference axis at a distance of one metre by a nominal power equal to the rated power handling capacity and referred to standard reference of 2×10^{-4} dynes/cm².

9.6 Nominal Efficiency — The quotient of the total acoustic power radiated (integrated over a sphere) to the nominal electrical input power at a given frequency or band of frequencies.

9.7 Power Handling Capacity — That power which the loudspeaker will satisfactorily handle. This is influenced by factors, such as mechanical damage and production of unacceptable distortion.

9.8 Rated Power Handling Capacity — That value of power handling capacity which a manufacturer assigns to his loudspeaker on the basis of his experience.

NOTE — It is usually understood as the undistorted power output of an amplifier with which the loudspeaker may be satisfactorily operated on normal programme material over an extended period without mechanical damage. It is not at present possible to legislate for distortion-limited power handling capacity although its importance is recognized; its value depends on acoustic loading and on several other factors difficult to specify.

9.9 Transient Response — Under consideration.

9.10 Effective Frequency Range — The upper frequency limit is that from which the response of the loudspeaker, expressed in decibels, measured on the reference axis at a specified distance from the reference point (normally one metre), does not fall by more than the stated amount (normally 10 dB) below the mean response averaged over a bandwidth of one octave in the region of maximum sensitivity.

NOTE — Sharp peaks and troughs in the response curve may be neglected provided such irregularities do not exceed 1/8 octave.

For the lower frequency limit, the resonance frequency of the loud-speaker shall be taken.

9.11 Rated Frequency Range — That restricted frequency range which a manufacturer may assign to the loudspeaker for a special purpose.

10. MISCELLANEOUS TRANSDUCERS

10.1 Hydrophone — An electro-acoustic transducer that transforms waterborne acoustic signals into electrical form.

10.2 Underwater Sound Projector — An electro-acoustic transducer used to produce sound in water.

10.3 Earphone — An electro-acoustic transducer which transforms electrical energy into sound energy and is intended to be closely coupled acoustically to the ear.

10.3.1 Insert Earphone (Insert Receiver) — An earphone of small dimensions associated with a fitting for insertion into the auditory meatus.

10.3.2 Telephone Earphone (Telephone Receiver) — An earphone designed for use in a telephone system.

10.4 Bone Conduction Headphone (Bone Conduction Receiver) — An electromechanical transducer which transforms electrical oscillations into mechanical vibrations and is intended to be closely coupled to the bony structure (usually the mastoid).

10.5 Vibration Pick-Up — Under consideration.

APPENDIX A

(Clause 7.6)

FORMULAE FOR MICROPHONE RATING

A-1. In accordance with the definition given in 7.6, the microphone rating G_M is calculated from the following formula:

$$G_M = 10 \log_{10} \frac{\left(\frac{E^2}{4 R_{MR}} \right) / (P_o)}{\left(\frac{p}{p_o} \right)^2}$$

where

E = open-circuit voltage in volts generated by the microphone,
 p = free-field sound pressure of a plane progressive wave existing at the microphone location prior to the introduction of the microphone into the sound field,

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$20 \log_{10} (E/p)$ = response to a plane progressive sound wave whose direction of propagation has a specified orientation with respect to the principal axis of the microphone,

P_o = reference power,

p_o = reference pressure, and

R_{MR} = microphone rating resistance. This resistance is to be taken from the following table:

<i>Magnitude of Nominal Microphone Impedance at 100 c/s and 20°C</i>	<i>Rating Impedance</i>
19 to 75 ohms	38 ohms
76 to 300 ohms	150 ohms
301 to 1 200 ohms	600 ohms
1 201 to 4 800 ohms	2 400 ohms
4 801 to 20 000 ohms	9 600 ohms
20 001 to 80 000 ohms	40 000 ohms
80 001 ohms or more	100 000 ohms

NOTE 1 — If $P_o = 1$ W, $p_o = 1$ microbar and E/p is in units of volts per microbar, for practical application the defining equation becomes:

$$G_M = [20 \log_{10} (E/p) - 10 \log_{10} 4 R_{MR}]$$

and the unit of G_M is the decibel with reference to 0.001 W per (0.000 2 microbar) squared.

NOTE 2 — If $P_o = 0.001$ W, $p_o = 0.000 2$ microbar and E/p is in units of volts per microbar, for practical application

$$G_M = [20 \log_{10} (E/p) - 10 \log_{10} 4 R_{MR} - 44]$$

and the unit of G_M is the decibel with reference to 0.001 W per (0.000 2 microbar) squared.

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BOMBAY 400093

†Eastern : 1/14 C. I. T. Scheme VII M. V. I. P. Road, 36 24 99
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Gangotri Complex, 5th Floor, Bhadbhada Road, T. T. Nagar, 6 27 16
BHOPAL 462003

Plot No. 82/83, Lewis Road, BHUBANESHWAR 751002 5 36 27

53/5 Ward No. 29, R. G. Barua Road,
5th Byelane, GUWAHATI 781003 —

5-8-56C L. N. Gupta Marg, (Nampally Station Road), 22 10 83
HYDERABAD 500001

R14 Yudhister Marg, C Scheme, JAIPUR 302005 { 6 34 71
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